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FLOOD INSURANCE STUDY

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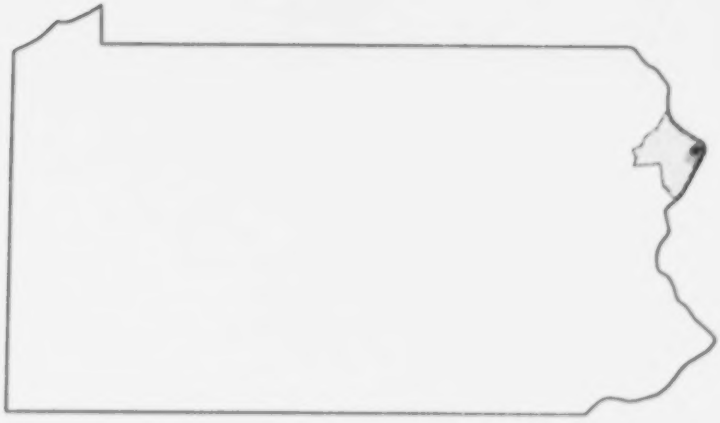
TOWNSHIP OF WESTFALL, PENNSYLVANIA
PIKE COUNTY



FEBRUARY 2, 1989

Federal Emergency Management Agency

COMMUNITY NUMBER - 421970

NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program (NFIP) have established repositories of flood hazard data for floodplain management and flood insurance study purposes. This Flood Insurance Study (FIS) may not contain all data available within the repository. It is advisable to contact the community repository for any additional data.

TABLE OF CONTENTS

1.0	INTRODUCTION	1
	1.1 Purpose of Study	1
	1.2 Authority and Acknowledgments	1
	1.3 Coordination	1
2.0	AREA STUDIED	2
	2.1 Scope of Study	2
	2.2 Community Description	2
	2.3 Principal Flood Problems	4
	2.4 Flood Protection Measures	5
3.0	ENGINEERING METHODS	5
	3.1 Hydrologic Analyses	6
	3.2 Hydraulic Analyses	6
4.0	FLOODPLAIN MANAGEMENT APPLICATIONS	8
	4.1 Floodplain Boundaries	8
	4.2 Floodways	9
5.0	INSURANCE APPLICATIONS	10
6.0	FLOOD INSURANCE RATE MAP	11
7.0	OTHER STUDIES	11
8.0	LOCATION OF DATA	12
9.0	BIBLIOGRAPHY AND REFERENCES	12

FIGURES

Figure 1 - Vicinity Map 3

Figure 2 - Floodway Schematic 9

TABLES

Table 1 - Summary of Discharges 6

EXHIBITS

Exhibit 1 - Flood Profiles
Delaware River Panels 01P-05P

Exhibit 2 - Flood Insurance Rate Map Index and Street Index
Flood Insurance Rate Map

Exhibit 3 - Elevation Reference Marks

FLOOD INSURANCE STUDY
TOWNSHIP OF WESTFALL, PIKE COUNTY, PENNSYLVANIA

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the Township of Westfall, Pike County, Pennsylvania, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates and assist the community in its efforts to promote sound floodplain management. Minimum floodplain management requirements for participation in the National Flood Insurance Program (NFIP) are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some states or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the state (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgments

The sources of authority for this Flood Insurance Study are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study were prepared by the Philadelphia District of the U. S. Army Corps of Engineers (COE) for the Federal Emergency Management Agency (FEMA), under Inter-Agency Agreement No. EMW-85-E-1822, Project Order No. 1, Amendment No. 16. This work was completed in February 1987.

1.3 Coordination

In December 1984, an initial Consultation and Coordination Officer's (CCO) meeting was held with representatives from FEMA, the township, and the COE (the study contractor) to determine the streams to be studied by detailed methods. A search for basic data was made at all levels of government. Subsequently, the COE was supplied a community map by community officials, and the U. S. Geological Survey (USGS) supplied topographic maps that were used in the preparation of this study.

On November 5, 1987, a final CCO meeting was held with representatives from FEMA, the township, and the study contractor to review the results of the study.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the Township of Westfall, Pike County, Pennsylvania. The area of study is shown on the Vicinity Map (Figure 1).

The Delaware River was studied by detailed methods from the downstream corporate limits to the downstream corporate limits of Matamoras. The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development and proposed construction through February 1992.

The remaining portions of the Delaware River were studied by approximate methods. Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to, and agreed upon by, FEMA and Township of Westfall.

2.2 Community Description

The Township of Westfall is located in Pike County in Pennsylvania. It is bordered by the Town of Lumberland, New York, to the north; the Town of Deer Park, New York, to the northeast; the Township of Montague, New Jersey, to the southeast; the Township of Milford to the south; and the Township of Shohola to the west. The Borough of Matamoras is located at the eastern tip of the township. The Township of Westfall covers an area of approximately 20,000 acres and had a 1982 population of 1,942. It is a second class township, which is governed by a three member Board of Supervisors.

The Delaware River forms the northern, eastern, and a portion of the southern boundary of the township. Numerous mountain streams that drain into the Delaware River are located within the township.

The climate in this geographic area is characterized by temperatures ranging from an average high of 68 degrees Fahrenheit (^{o}F) in summer and 30^{o}F in winter. The average annual rainfall for the region is 44 inches.

The topography of the area varies from steep mountain ranges to broad flat floodplains along the Delaware River, south of Interstate Route 84. The majority of the township is undeveloped with most of the development lying along or near the Delaware River. Approximately 31 percent of the land within the township is owned by the State Bureau of Forestry.

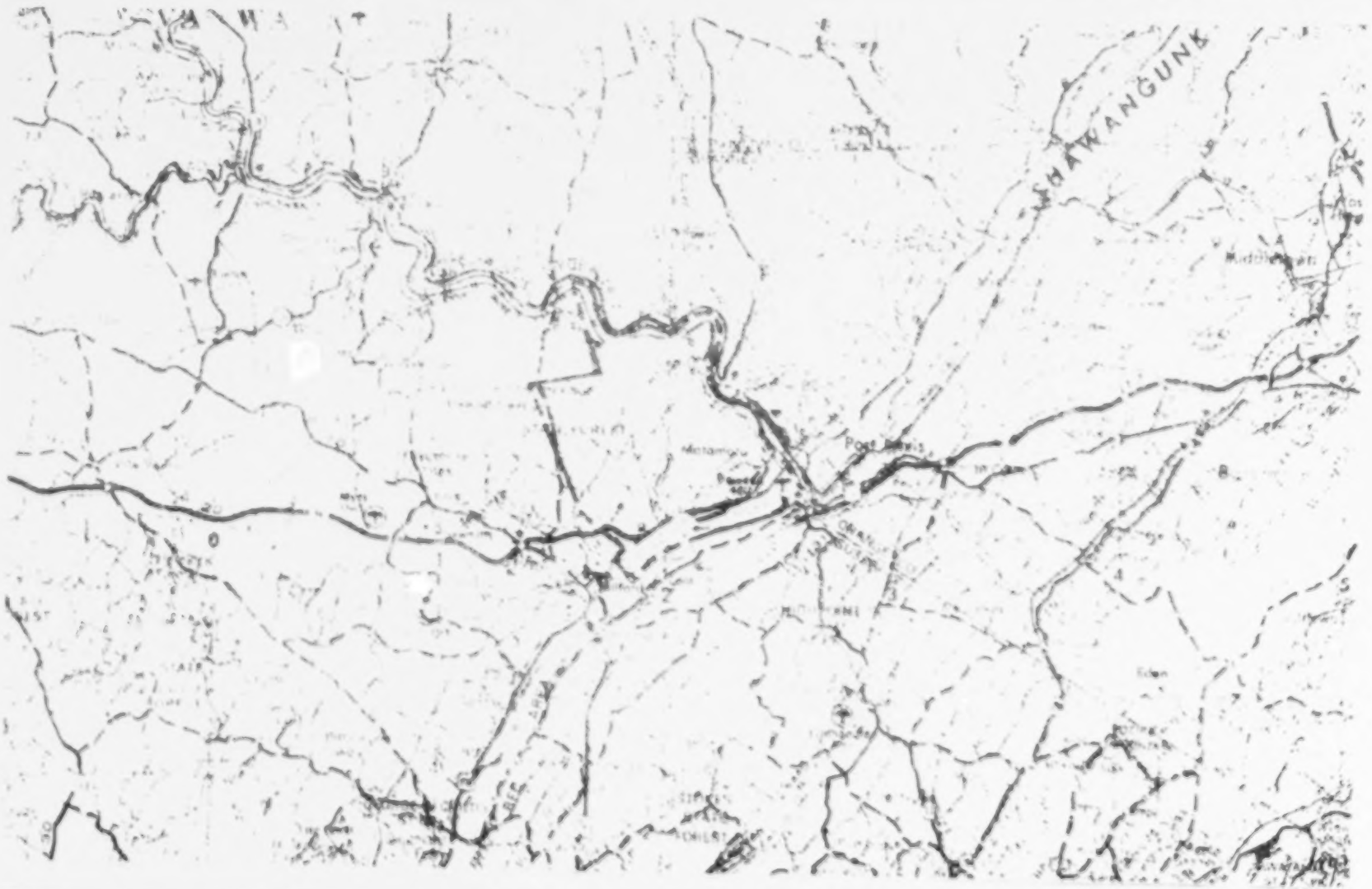


FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF WESTFALL, PA

(PIKE CO.)

APPROXIMATE SCALE

0 4 8 12 MILES

VICINITY MAP

2.3 Principal Flood Problems

The principal flood problems in the Township of Westfall are associated with the Delaware River below the Borough of Matamoras. Flooding occurs as a result of heavy runoff and ice jams that form downstream of the Port Jervis-Matamoras area. The nine highest recorded stages at the USGS stream gage No. 01434000 with a drainage area of 3,076 square miles (1904 to present) at Port Jervis are shown in the following tabulation:

Date	Stage (feet)[1]	Cause
02-12-81	26.6	Ice jams
03-08-04	25.5	Ice jams
08-19-55	23.9	Hurricane
10-10-03	23.1	Hurricane
05-23-42	17.8	Rainfall
03-18-36	17.6	Rainfall and Snowmelt
06-29-73	16.5	Rainfall
03-28-14	16.0	Rainfall
02-05-82	15.8	Ice jams

[1]Gage is 415.35 feet. The stage at the gage at which damage starts to occur in the study area from ice jam events is 15.65 feet.

In addition to these flood events, ice-related flooding also occurred in March 1875, which preceded the period of gage records. Based on newspaper accounts, the estimated stage for the event was between 18 and 25.5 feet, placing it as either the third, fourth, or fifth highest known stage.

Ice jams were responsible for four major floods since 1875 and have caused the two (possibly three) highest known stages. Ice jams occur in the community from January through March, generally when a heavy ice cover along the upper Delaware River is rapidly broken up by a winter freshet. Breakup usually begins near Hancock, New York, which is approximately 75 miles above Port Jervis. Although successive ice jams are formed and washed out as the breakup progresses downstream, the most damaging floods have always occurred in the Port Jervis-Matamoras area.

During the 1981 flooding event, an ice jam formed at a point approximately 5 miles downstream from Port Jervis where the Thirsty Deer and Mashipacong Islands divide the flow of the Delaware River. Backup from the jam gradually progressed upstream. The situation was aggravated when several ice jams that had formed upstream of Port Jervis and Matamoras broke loose. As a result, low lying areas of the Township of Westfall were damaged, and the banks in Matamoras and levees in Port Jervis were overtopped. Approximately 950 structures sustained damages amounting to 14.7 million dollars.

In February 1982, a State of Emergency was declared by local officials due to the threat of yet another ice jam. Again, the jam developed at Thirsty Deer and Mashipacong Islands and backed up into the community. Fortunately, the stages were not severe enough to cause damages.

After the ice jam flood of 1981, the National Weather Service instituted an ice observation and reporting program. Reports are now provided on a teletype network to all interested parties including the County Emergency Operation Directors.

In addition to the peak events shown in the tabulation, it should be noted that ice blockage forms at Thirsty Deer and Mashipacong Islands nearly every year. The degree of ice blockage and backup in the community varies and flood damages only result on the most severe occasions.

2.4 Flood Protection Measures

The COE has prepared a report and has recommended that a project involving a diversion channel at Mashipacong Island in the Township of Montague be authorized for implementation as a Federal project (Reference 1). This project should alleviate the ice related flood problems.

Discharges on the Delaware River through the Township of Westfall are regulated by Cannonsville, Pepacton, Prompton and Jadwin, and Neversink and Wallenpaupack Reservoirs. The fluvial water-surface profiles presented in this study reflects the regulated discharge due to these reservoirs.

Residents of Westfall depend on the usual warnings issued through radio, television, and local newspapers for information concerning possible flood conditions. Flood warnings and predicted flood peaks are issued by the National Oceanic and Atmospheric Administration (NOAA) Flood Forecasting Centers located at Harrisburg, Pennsylvania, and Trenton, New Jersey.

3.0 ENGINEERING METHODS

For the flooding source studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. A flood event of a magnitude which is expected to be equaled or exceeded once on the average during any 100-year period (recurrence interval) has been selected as having special significance for floodplain management and for flood insurance rates. This event, commonly termed the 100-year flood, has a 1 percent chance of being equaled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases

when periods greater than 1 year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (1 percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for the flooding source studied in detail affecting the community.

Flooding caused by two distinct conditions was considered in the preparation of this report. The hydrologic data for fluvial conditions on the Delaware River was obtained from the COE Delaware River Basin Study, Survey Report and reflects the regulated discharge due to reservoirs located upstream of the community (Reference 1). The hydrologic data on the Delaware River for the ice jam conditions is based on information obtained during the preparation of the COE Ice Related Flood Control Study (Reference 2).

A summary of the drainage area-peak discharge relationships for the Delaware River is shown in Table 1, "Summary of Discharges."

TABLE 1 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGE (cfs) 100-YEAR
DELAWARE RIVER		
(Fluvial Conditions)		
At Montague stream gage (No. 01438500)	3,480	187,000
At Port Jervis stream gage (No. 01434000)	3,076	170,000
(Ice Jam Conditions)		
Port Jervis stream gage (No. 01434000)	3,076	40,000[1]

[1] Recorded discharge for 1981 ice jam event at Port Jervis (assumed to be a 100-year ice jam event (Reference 2).

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals.

Cross sections and topographic maps developed during the Tocks Island Lake Project Study were used in this study as well as aerial photographs of the community. Cross sections were also taken from the Flood Insurance Study for the City of Port Jervis (Reference 3). The 1981 ice jam effects at several cross sections on the Delaware River are shown in the following tabulation:

Cross Section	Channel Distance[1]	Regulatory
A	2,977	409.5
B	5,470	411.9
C	8,123	413.4
D	10,869	414.7
E	11,915	415.2
F	13,195	416.0[2]
G	14,049	417.0[2]
H	15,090	419.0[2]
I	16,090	420.0[2]
J	17,049	421.0[2]
K	17,890	422.0[2]
L	18,845	424.0[2]
M	19,890	426.0[2]
N	21,100	428.0[2]
O	22,145	428.5[2]
P	22,825	430.0[2]
Q	23,870	431.0[2]
R	26,150	433.0[2]

[1]Feet above origin of study
[2]Elevation effected by ice jam

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1) and the Flood Insurance Rate Map (Exhibit 2) where applicable. Along certain portions of the Delaware River, a profile base line is shown on the maps to represent channel distances as indicated on the flood profiles and floodway data tables.

Water-surface elevations of floods of the selected recurrence intervals were computed using the COE HEC-2 step-backwater computer program (Reference 4). In areas where the 1981 ice jam effect is higher than the computed 100-year water-surface elevation, the ice jam effect elevation is the 100-year water-surface elevation. Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals. Starting water-surface elevations for the Delaware River were obtained from the rating curve at the Montague gage.

Stage and discharge records exist for the Delaware River at Montague and Port Jervis as well as the Neversink River at Port Jervis. The HEC-2 model was calibrated for open water flows by adjusting the Manning's "n" value for the channel bed while matching known water-

surface levels for a range of discharges. The model was then tested for an ice cover using flow, stage, and ice thickness data obtained during February 1985, a low flow period. The model treats an ice cover as a floating bridge and accounts for the increased shear stress of the underside of the ice cover by calculating a composite Manning's "n" value. The model was then calibrated for an ice jam event. Channel "n" values for the Delaware River ranged from 0.033 to 0.040, and the overbank "n" values ranged from 0.050 to 0.070.

The hydraulic analyses for this study for the free-flow condition were based on unobstructed flow. The ice jam condition analyses were based on partial blockage of hydraulic structures. The flood elevations shown on the profiles reflect the ice jam condition or the free-flow condition, whichever is higher.

All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD). Elevation reference marks used in this study are shown on the maps; the descriptions of the marks are presented in Elevation Reference Marks (Exhibit 3).

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound floodplain management programs. Therefore, each Flood Insurance Study provides 100-year flood elevations and delineations of the 100-year floodplain boundaries to assist communities in developing floodplain management measures.

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1 percent annual chance (100-year) flood has been adopted by FEMA as the base flood for floodplain management purposes. For the streams studied in detail, the 100-year floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps at a scale of 1:24,000 with a contour interval of 20 feet (Reference 5).

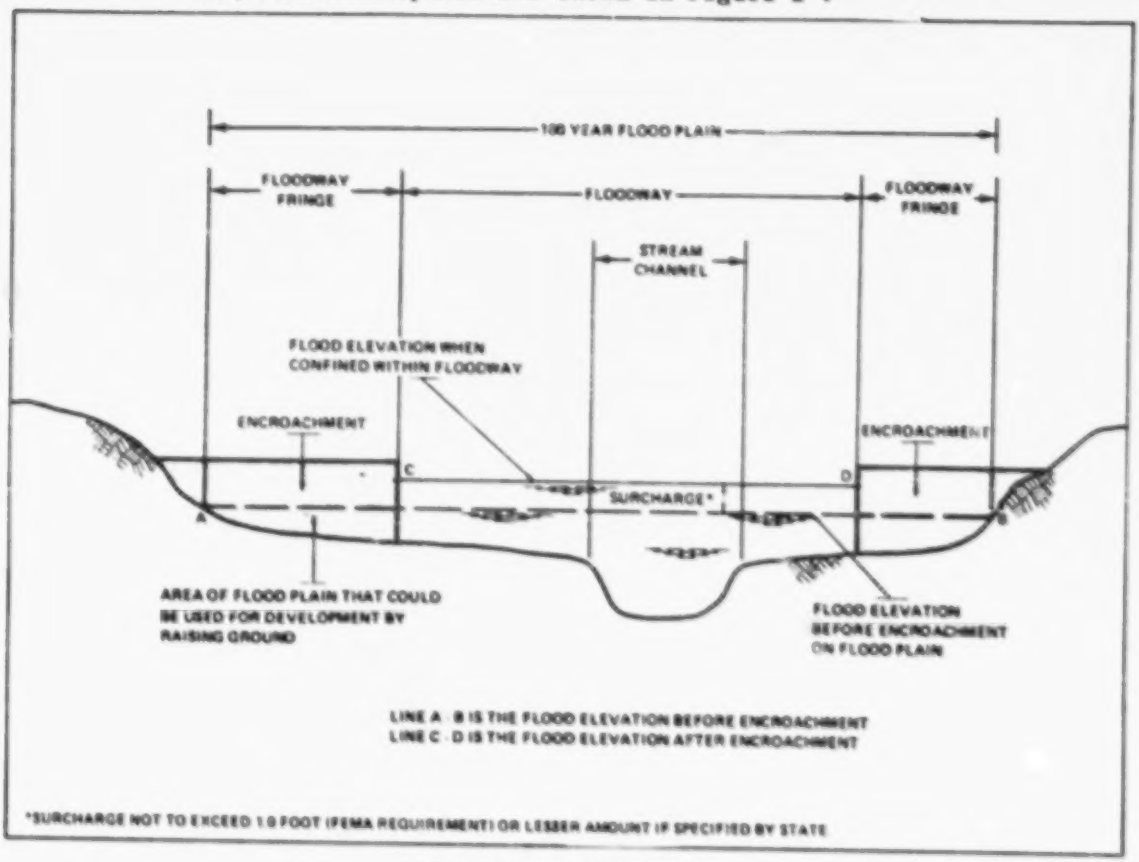
For the stream studied by approximate methods, the 100-year flood boundary was delineated using the Flood Hazard Boundary Map for the Township of Westfall (Reference 6).

The 100-year floodplain boundaries are shown on the Flood Insurance Rate Map (Exhibit 2). On this map, the 100-year floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A and AE). Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the National Flood Insurance Program, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 100-year floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the 100-year flood can be carried without substantial increases in flood heights. Minimum federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced.

The area between the floodway and 100-year floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 2 .


100 YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
A
B
SURCHARGE*
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE A - B IS THE FLOOD ELEVATION BEFORE ENCROACHMENT
LINE C - D IS THE FLOOD ELEVATION AFTER ENCROACHMENT
*SURCHARGE NOT TO EXCEED 1.0 FOOT (FEMA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE

FLOODWAY SCHEMATIC Figure 2

No floodways were calculated as part of this study.

5.0 INSURANCE APPLICATIONS

For flood insurance rating purposes, flood insurance zone designations are assigned to a community based on the results of the engineering analyses. The zones are as follows:

Zone A

Zone A is the flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the Flood Insurance Study by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no base flood elevations or depths are shown within this zone.

Zone AE

Zone AE is the flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the Flood Insurance Study by detailed methods. In most instances, whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AH

Zone AH is the flood insurance rate zone that corresponds to the areas of 100-year shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. Whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AO

Zone AO is the flood insurance rate zone that corresponds to the areas of 100-year shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average whole-depths derived from the detailed hydraulic analyses are shown within this zone.

Zone A99

Zone A99 is the flood insurance rate zone that corresponds to areas of the 100-year floodplain that will be protected by a Federal flood protection system where construction has reached specified statutory milestones. No base flood elevations or depths are shown within this zone.

Zone V

Zone V is the flood insurance rate zone that corresponds to the 100-year coastal floodplains that have additional hazards associated with storm waves. Because approximate hydraulic analyses are performed for such areas, no base flood elevations are shown within this zone.

Zone VE

Zone VE is the flood insurance rate zone that corresponds to the 100-year coastal floodplains that have additional hazards associated with storm waves. Whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone X

Zone X is the flood insurance rate zone that corresponds to areas outside the 500-year floodplain, areas within the 500-year floodplain,and to areas of 100-year flooding where average depths are less than 1 foot, areas of 10-year flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 100-year flood by levees. No base flood elevations or depths are shown within this zone.

Zone D

Zone D is the flood insurance rate zone that corresponds to unstudied areas where flood hazards are undetermined, but possible.

6.0 FLOOD INSURANCE RATE MAP

The Flood Insurance Rate Map is designed for flood insurance and floodplain management applications.

For flood insurance applications, the map designates flood insurance rate zones as described in Section 5.0 and, in the 100-year floodplains that were studied by detailed methods, shows selected whole-foot base flood elevations or average depths. Insurance agents use the zones and base flood elevations in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

For floodplain management applications, the map shows by tints, screens, and symbols, the 100-year floodplain. The locations of selected cross sections used in the hydraulic analyses are shown where applicable.

7.0 OTHER STUDIES

Flood Insurance Studies have been published for the Towns of Lumberland and Deer Park, New York; the City of Port Jervis, New York; and the Townships of Milford, Pennsylvania, and Montague, New Jersey (References 7, 8, 3, 9, and 10). The results of this study are in agreement with the results of the study for the Town of Lumberland. The results of this study are not in agreement with the Deer Park study, because the Delaware River was studied by detailed methods in this study and was studied by approximate methods in the Deer Park study. This study is not in agreement with the Port Jervis study, because this study uses more

updated analyses. This study is not in agreement with the studies for the Townships of Milford and Montague, because this study uses a more detailed analysis for the Delaware River.

A Flood Insurance Study for the Borough of Matamoras is currently being prepared (Reference 11). The results of that study will be in agreement with the results of this study.

Due to its more detailed nature, this study supersedes the Flood Hazard Boundary Map for the Township of Westfall (Reference 6).

8.0 LOCATION OF DATA

Information concerning the pertinent data used in preparation of this study can be obtained by contacting FEMA, the Natural and Technological Hazards Division, Liberty Square Building (Second Floor), 105 South Seventh Street, Philadelphia, Pennsylvania 19106.

9.0 BIBLIOGRAPHY AND REFERENCES

1. U. S. Army Corps of Engineers, Philadelphia District, Delaware River Basin Study, Survey Report, Philadelphia, Pennsylvania, August 1984.

2. U. S. Army Corps of Engineers, Philadelphia District, Ice Related Flood Control Study, Detailed Project Report and Environmental Impact Statement, Delaware River, Port Jervis, New York Area, Philadelphia, Pennsylvania, April 1986.

3. U. S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, City of Port Jervis, Orange County, New York, Washington, D. C., June 1, 1978.

4. U. S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-2 Water Surface Profiles, Generalized Computer Program, Davis, California, 1982.

5. U. S. Department of the Interior, Geological Survey, 7.5-Minute Series Topographic Maps, Scale 1:24,000, Contour Interval 20 Feet: Milford, Pennsylvania-New Jersey, 1958, Photorevised 1983; Pond Eddy, New York-Pennsylvania, 1965, Photorevised 1973; Port Jervis, North, New York-Pennsylvania, 1969; Port Jervis, South, New Jersey-New York-Pennsylvania, 1969.

6. Federal Emergency Management Agency, Federal Insurance Administration, Flood Hazard Boundary Map, Township of Westfall, Pike County, Pennsylvania, February 8, 1980.

7. Federal Emergency Management Agency, Flood Insurance Study, Town of Lumberland, Sullivan County, New York, Washington, D. C., February 27, 1984.

8. Federal Emergency Management Agency, Flood Insurance Study, Town of Deer Park, Orange County, New York, Washington, D. C. March 18, 1987.

9. Federal Emergency Management Agency, Flood Insurance Study, Township of Milford, Pike County, Pennsylvania, Washington, D. C., December 4, 1985.

10. Federal Emergency Management Agency, Flood Insurance Study, Township of Montague, Sussex County, New Jersey, Washington, D. C., March 4, 1983.

11. Federal Emergency Management Agency, Flood Insurance Study, Borough of Matamoras, Pike County, Pennsylvania (Unpublished).

Community Map, Map of Inundated Area during 1981 Ice-Jam Event in the Township of Westfall.

EXHIBIT 3 - ELEVATION REFERENCE MARKS

Reference Mark	FIRM Panel	Elevation (Feet NGVD)	Description of Location
RM 1	15	509.23	PDH disk set on top of southeast concrete headwall of Broad Street bridge over Vandemark Creek at Milford; approximately 0.8 foot northeast of southwest end of headwall.

* ORIGIN OF STUDY IS LIMIT OF FLOODING AFFECTING COMMUNITY 1160' DOWNSTREAM OF CORPORATE LIMITS

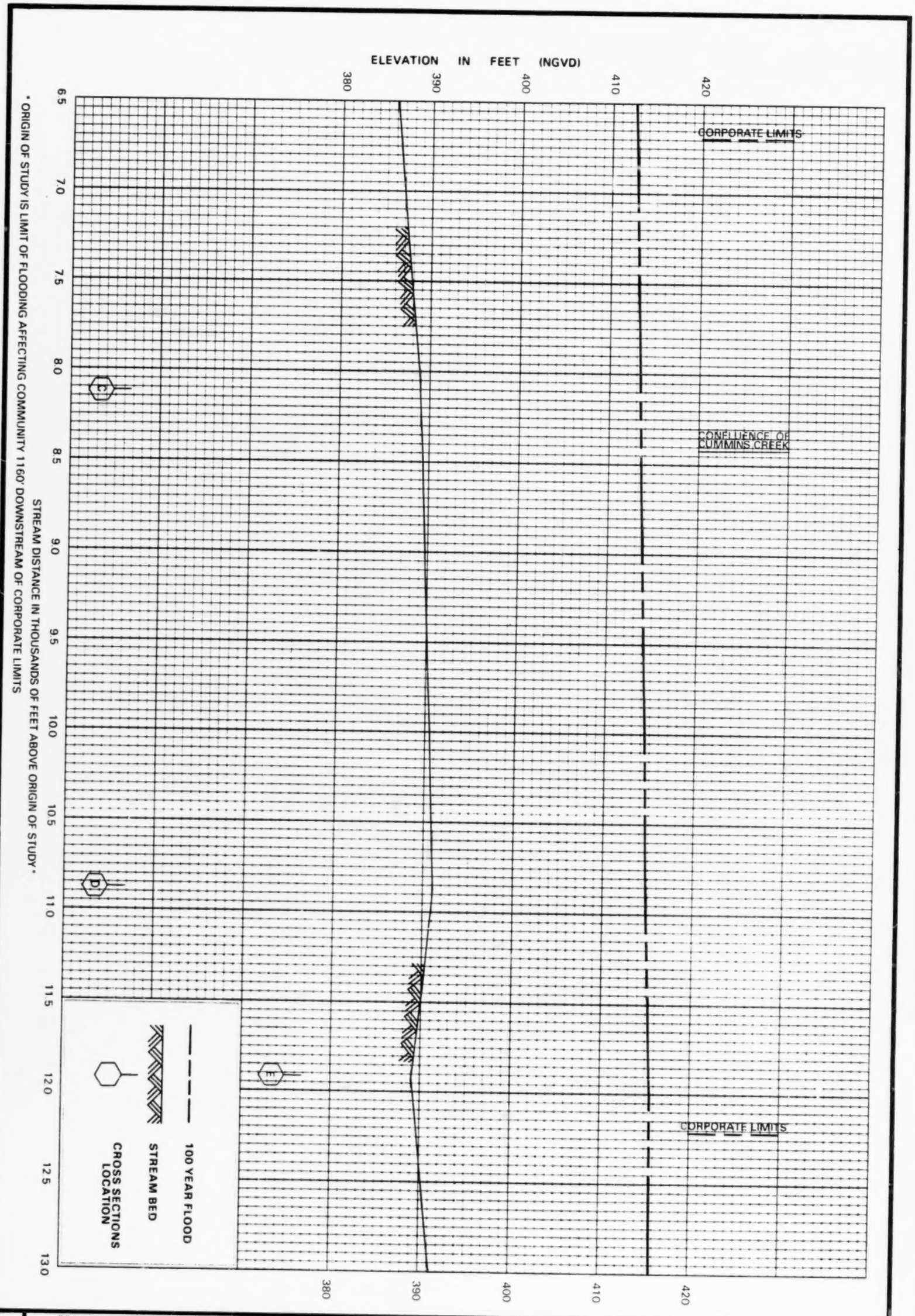
FLOOD PROFILES

DELAWARE RIVER

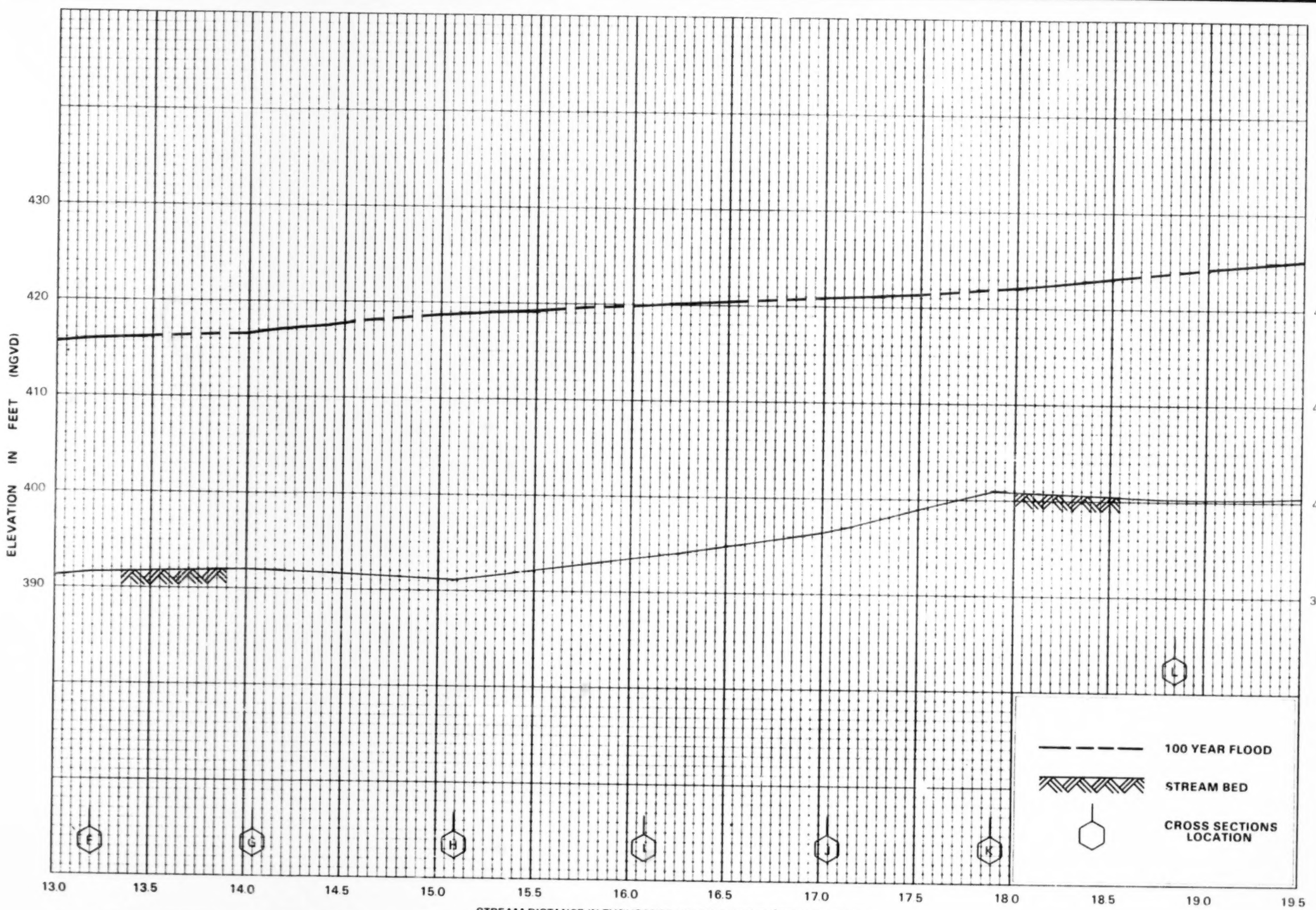
FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF WESTFALL, PA
(PIKE CO.)

01P



02P	FEDERAL EMERGENCY MANAGEMENT AGENCY TOWNSHIP OF WESTFALL, PA (PIKE CO.)	FLOOD PROFILES DELAWARE RIVER



* ORIGIN OF STUDY IS LIMIT OF FLOODING AFFECTING COMMUNITY 1160' DOWNSTREAM OF CORPORATE LIMITS

FLOOD PROFILES

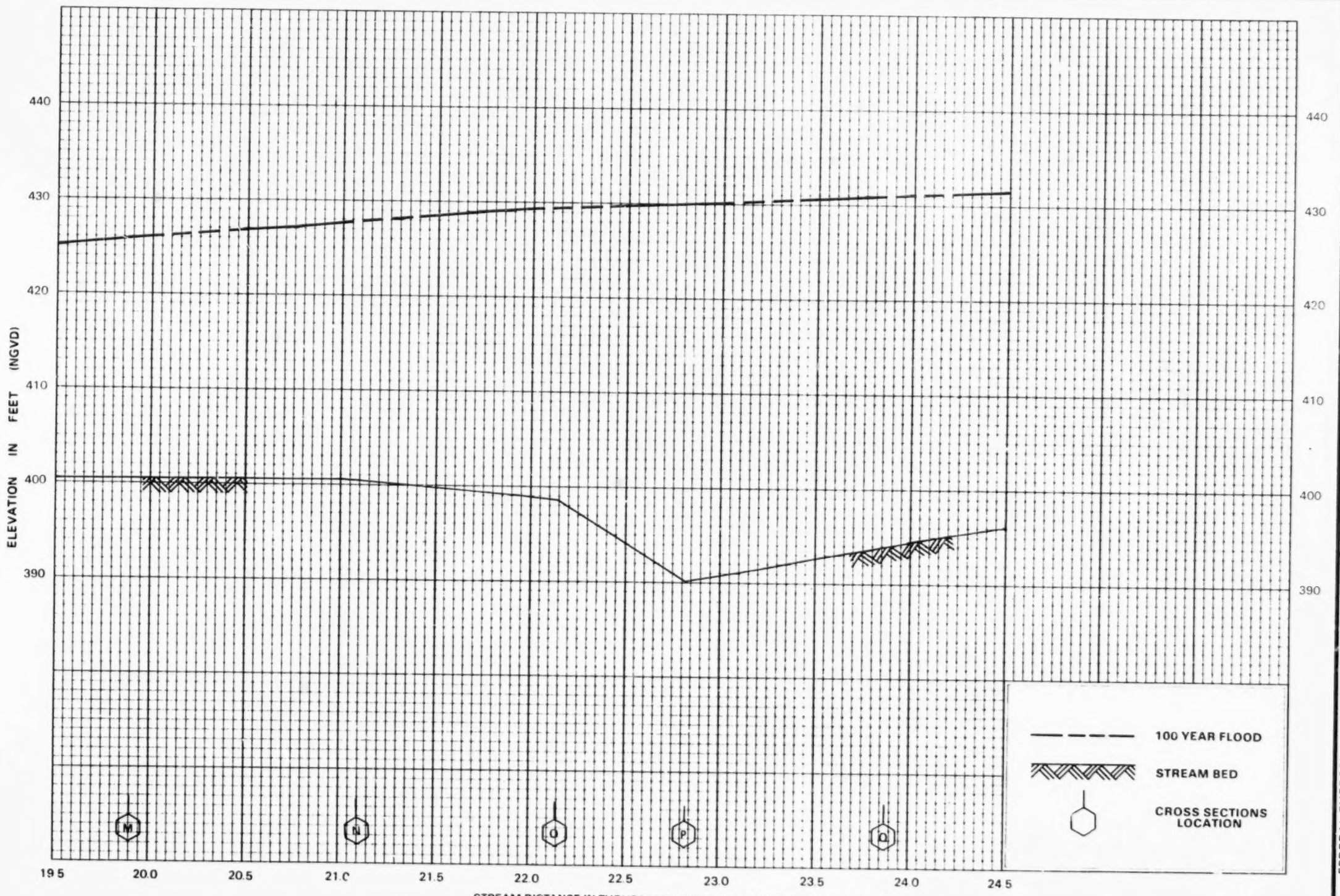
DELAWARE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF WESTFALL, PA

(PIKE CO.)

03P



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FLOOD PROFILES

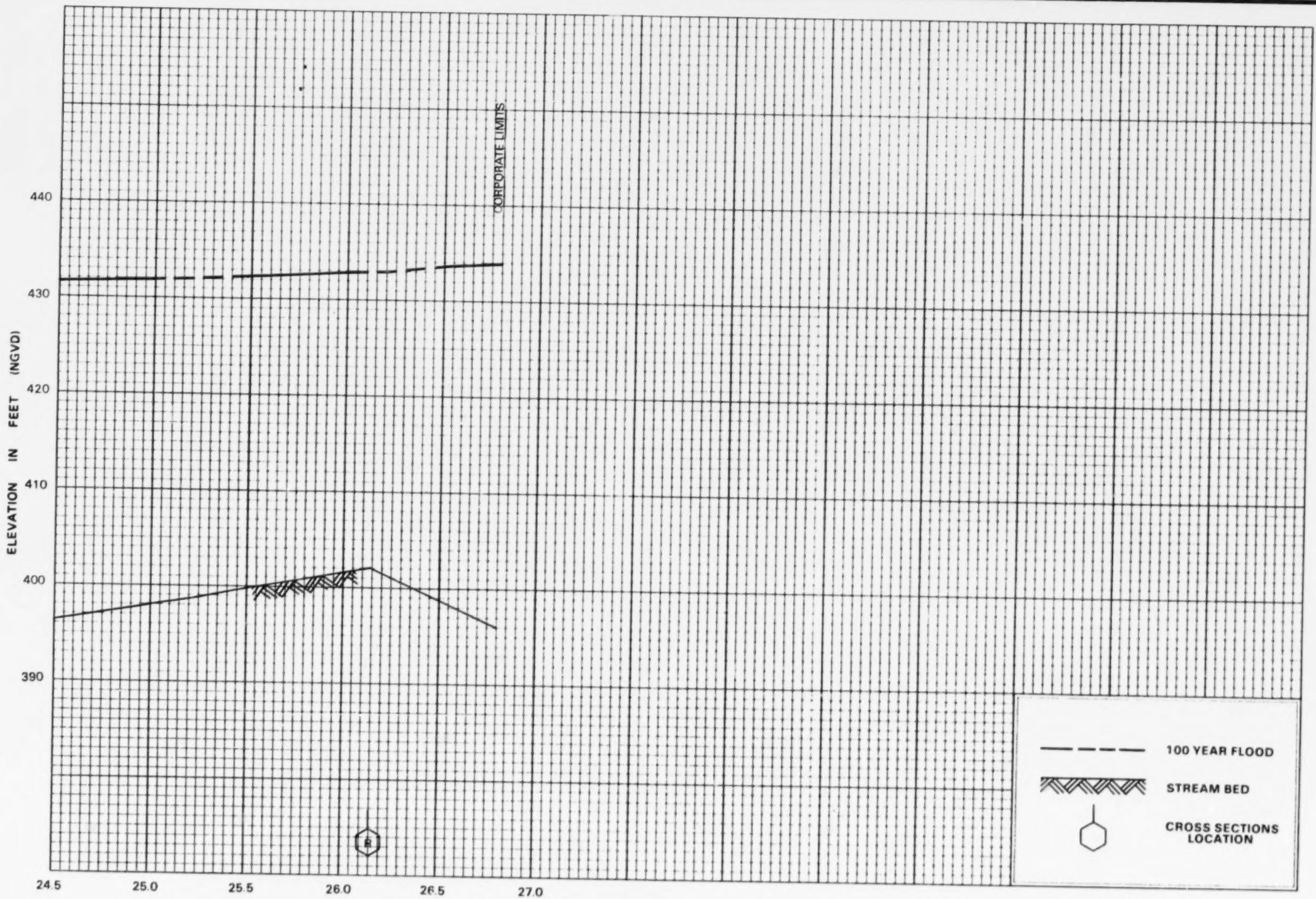
DELAWARE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF WESTFALL, PA

(PIKE CO.)

04P



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FLOOD PROFILES

DELAWARE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF WESTFALL, PA
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